Impacts of Adoption of the New Threshold Limit Value For Beryllium

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Issue: New Threshold Limit Value for Beryllium

In 2009 the American Conference of Governmental Industrial Hygienists (ACGIH) issued a revised Threshold Limit Value (TLV) for beryllium.

- 0.05 ug/m^3, 8hr TWA.
- Inhalable particle fraction sample.

Should DOE sites adopt the new TLV?

- DOE incorporated the 2005 TLVs in 10 CFR 851.
- Site contract may require use of the *latest* TLV.
- OSHA is developing a beryllium standard.
- Sites may chose to adopt the new TLV as a more conservative protective measure.

Problem: Measuring Very Low Exposure Limit

- 0.05 ug/m^3 (even with a full shift sample), may be near or below the quantification limit of some analytical laboratories.
- The method of analysis can effect choice of sampler (and vice-versa).
- Industrial hygienists generally desire an analytical quantification limit ten fold lower than the exposure limit.
- An exposure limit at or near the quantification limit does not allow for adequate statistical analysis of sample distribution or trends.
- No “comfort zone” for industrial hygienists or managers.

Problem: Measuring Very Low Exposure Limit

Sample detection limit (ug/m^3) for a full shift sample (480 minutes) at various flow rates and analytical quantification limits.

Flow Rate (liters/minute)	Limit of Quantification (ug/sample) 0.005	0.01	0.03	0.05
2.0	0.005	0.010	0.031	0.052
3.5	0.003	0.006	0.018	0.030
4.0	0.003	0.005	0.016	0.026

IH Comfort Factor: ≥ 10 Green; ≥ 5 Yellow; < 5 Red.

Problem: Sample Analysis Concerns

- Transition to methods like ICP-MS at significant additional cost for capital equipment, maintenance, and the higher level of operator skill and ability required.
- Fluorescence methods may provide an adequate quantification limit at a more reasonable cost, but require further development and greater general acceptance.
- The lab must be accredited by the AIHA for any methods used for analysis of samples used for personal exposure monitoring.
- Handling and processing of samplers a significant issue.
- Sample analysis will not be covered in this talk. It requires further evaluation and deserves additional time.

Particle Size Fractions

ISO 7708:1995 Particle size fraction definitions for health-related sampling.

- **Inhalable (full respiratory tract)**
  - Median cut point 100 um.
- **Thoracic (lung airways and gas-exchange region)**
  - Median cut point 10 um.
- **Respirable (gas-exchange region)**
  - Median cut point 4 um.

ACGIH intends for all TLVs to eventually specify an ISO particle size fraction.

Problem: Different Sampler Required

The standard 3 piece 37 mm cassette typically used for metals sampling does not meet **any** of the ISO particle size sampling criteria.

Available Inhalable Samplers

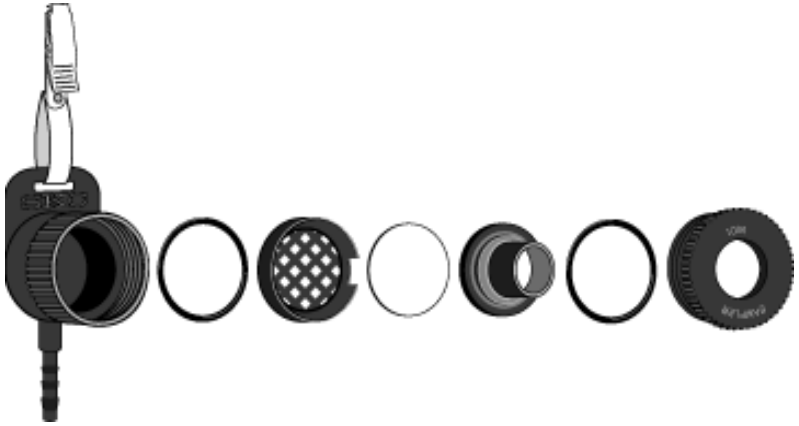
Button
4 lpm
25 mm

IOM
2 lpm
25 mm

CIS
3.5 lpm
37 mm

IOM Sampler Flow/Pressure Test

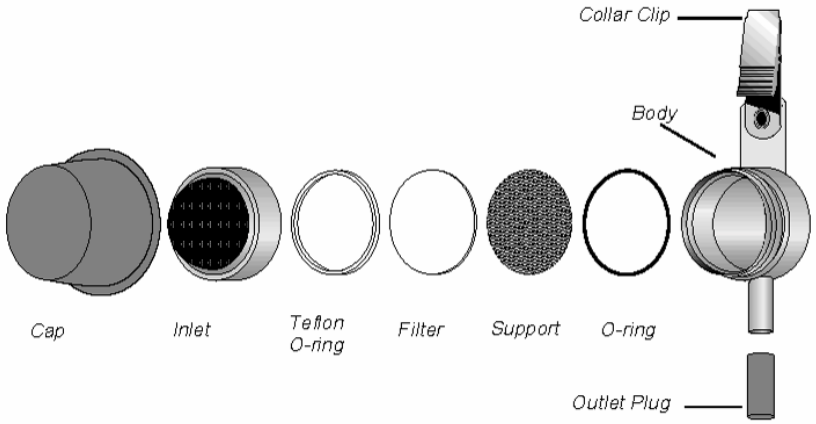
Filter	Pressure	Flow
5 um PVC	9 cm H_2O	2 lpm
1.2 um MCE	23 cm H_2O	2 lpm
0.8 um MCE	52 cm H_2O	2 lpm
37 mm CFC	14 cm H_2O	2 lpm



Note: Problems with leaks in calibration adaptor.

Button Sampler Flow/Pressure Test

Filter	Pressure	Flow
5 um PVC	12 cm H_2O	4 lpm
1.2 um MCE	42 cm H_2O	4 lpm
0.8 um MCE	76 cm H_2O	3.4 lpm
37 mm CFC	28 cm H_2O	4 lpm



Note: Pump failure within minutes with 0.8 um filter.

CIS Sampler Flow/Pressure Test

Filter	Pressure	Flow
5 um PVC	7 cm H_2O	3.5 lpm
0.8 um MCE	28 cm H_2O	3.5 lpm
37 mm CFC	28 cm H_2O	4 lpm

Note: <u>No</u> calibration adaptor !

Survey of Commercial Analytical Laboratories

- Accredited laboratories participating in the IHLAP Program were identified on AIHA web page.
- 42 laboratories selected based on listing of analytical methods and/or participation in the BeLAP.
- Letters sent with questions on the handling and processing of inhalable samplers.
- Eight laboratories responded via letter, email, or telephone.
- Four of the responding labs indicated they handled and analyzed inhalable samplers. Others indicated no demand.

Questions and Responses from Labs

- Do you provide guidance on collecting and handling inhalable particle fraction samples?
  - Two labs said yes. One said would provide if requested. One said customer gets guidance from sampler manufacturer.
- Do you require a specific sampler?
  - One required the SKC IOM sampler. Remainder prefer IOM but would consider other. One analyzed occasional button samplers.
- How do you deal with material deposited on the walls of the internal filter cassette to ensure it is included with the filter in the sample analysis?
  - Two labs said not an issue as only gravimetric analysis used. One lab rinses and adds to sample. One lab wipes **all** sample cassettes for metals analysis and adds to sample.

Questions and Responses from Labs

- Do you or the customer provide the inhalable sampler?
  - Two labs provides to customers. One lab provides only to local customers. One lab rents to those who don't own.
- Would the customer remove the filter or filter cassette from the sampler; or would the customer send the entire sampler to your laboratory?
  - All labs indicate the entire sampler is sent.
- Do you have a quality assurance and testing program to ensure the samplers sent to customers are not contaminated?
  - All labs indicated yes, but with varying levels of formality.

Indications from Commercial Lab Survey

- Very little demand for inhalable sampler analysis.
- Majority of inhalable samples are for gravimetric analysis.
- IOM is sampler of choice by commercial analytical labs.
- In general, commercial analytical laboratories are not prepared for large-scale analysis of beryllium samples collected using inhalable samplers.
- A higher demand would likely result in more commercial laboratories handling and analyzing inhalable samplers at competitive rates.

Cleaning of Samplers

- No matter what sampler is selected or who does the analysis, sampler cleaning will be required.
- New samplers arrived with residual grease and dirt.
- The low exposure limit makes the potential for residual contamination in the sampler a serious concern. (0.05 ug ≈ 37 um particle)
- Stringent adherence to validated cleaning and re-loading procedures required.
- Strict adherence to a quality assurance program will be required.

Cleaning Methods and Issues

- Manufacturers recommend soapy water. Ultrasonic recommended for IOM. Cautions on solvents.
- Special attention must be paid to gaskets.
- Experience at LANL indicates a three stage ultrasonic system is very effective at removing beryllium particles.
- Means to initially validate and periodically test cleaning methods will need to be determined.
- Available space for cleaning, drying, and assembling samples may be an issue at some sites.
- May create an additional waste stream.

Costs for Using Inhalable Samplers

- Approximate cost for samplers:
  - IOM (plastic) $ 104.00 ($20.00 extra cassette)
  - IOM (stainless) $ 319.00 ($95.00 extra cassette)
  - Button $ 213.00
  - CIS $ 82.50 ($8.25 extra cassette)
  - 25 mm MCE filter $ 0.50
  - CFC (pre-loaded) $ 1.30
- Personal sampling pumps.
  - $700 to $1000 for pumps meeting requirements.
- Number required may equal number of samples/month.
  - Average weekly use must be “ready”.
  - Assume one week in field and one week in lab.
  - Assume use at multiple locations.

Costs for Using Inhalable Samplers

- Additional equipment and materials.
  - Ultrasonic cleaner $ 1000.00
  - Other miscellaneous $ 2000.00
- Consumables.
  - $100 to $300 per month.
- Additional technician time to handle and process inhalable samplers.
  - Estimated one-quarter to one-half FTE.

Note: Cost estimates are best guesses and can vary widely depending on individual site circumstances.

It's Not Just Beryllium

- 2009 ACGIH booklet lists 78 inhalable TLVs.
  - 27 Inhalable Fraction (I)
  - 51 Inhalable Fraction and Vapor (IFV)
- 28 inhalable TLVs are ≤ 0.05 mg/m^3.
- 9 inhalable TLVs are on NIC list.
- ACGIH intends for all TLVs to eventually specify a particle size fraction.
- With 78 inhalable fraction TLVs, why don't the commercial laboratories see more demand?

Additional Work Needed

- Review of literature comparing inhalable samplers under different conditions.
- Evaluation of various sampling scenarios and determining required analytical sensitivity.
- Evaluate on-site vs. off-site analytical costs.
- Determine means to validate sampler cleaning methods.
- Determine time and effort required to implement and maintain use of inhalable samplers.

This Is What We Need (Wish List)

- New generation of personal sampling pumps.
  - Standard Flow: Light weight and quiet; 2 to 4 liters per minute for 12 or more hours.
  - High Flow: A bit larger and heavier, but capable of pulling 10 to 15 liters per minute for up to 10 hours.

- Pre-loaded disposable samplers for each ISO particle fraction.
  - Handle like current closed faced cassettes.
  - Color coded to reduce field selection errors.
  - Standard and high flow series (total of 6 samplers).
  - Designed for ease of handling during analysis.

Resources

- SKC Inc.
  - http://www.skcinc.com/
- BGI Instruments
  - http://www.bgiusa.com/
- AIHA Laboratory Accreditation Programs
  - http://www.aihaaccreditedlabs.org/Pages/default.aspx

Questions

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